

Lighting: types, qualities and impacts

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Commission for Dark Skies (CfDS)

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Venus rises over the Cranborne Chase AONB, June 24 2015

Photo: Bob Mizon

CONTENTS

Different types of lighting through the years.....	3
Terms used in describing good lighting, and waste light not directed to the area to be lit.....	6
A new threat to the environment: uncontained, blue-rich white lighting.....	8
Putting light where it is needed.....	9
Part-night switch-offs – the CfDS view.....	9
Common misconceptions met when discussing quality lighting and good practice.....	11

1) Different types of lighting through the years¹

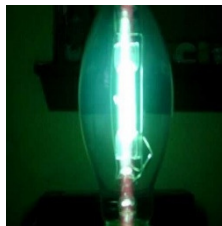
The earliest practical lights, used both inside and out, were incandescent **tungsten** filament bulbs, creating light from the heating of a metal wire. They are still commonly used for indoor domestic purposes.

Photo: Don Hied



The next development, mainly in street lighting, was the **mercury-vapour** discharge lamp, rarely seen nowadays, emitting a blue-white light, having low efficiency and fairly short life.

Photo: CfDS



Many of the over-bright “security” lamps sold over the last few decades are of the **tungsten-halogen** type, very energy-inefficient and short-lived.

Photo: Philip Perkins



The 1960s and 1970s saw the rise of **low-pressure sodium** lamps (known in lighting circles as **SOX**), giving a bold orange light beneath which colours are 'muddied'. This is a relatively energy-efficient light, and the lamps have a long life. Astronomers favour these as they are monochromatic and can be filtered out when using telescopes and binoculars. These are on the way out, and will rapidly disappear in favour of whiter lights.



Photo: Bob Mizon

High-pressure sodium (SON) started to replace SOX in the late 1970s. SON lamps are much smaller than SOX, which could be nearly a metre long. SON can therefore be more easily enclosed in a reflector that directs the light where it is needed. SON energy efficiency is not as good as SOX but they are longer-lived. SON gives a pinkish-orange light and is still very often seen on both major and minor roads.



*Photo: Chris
Baddiley*

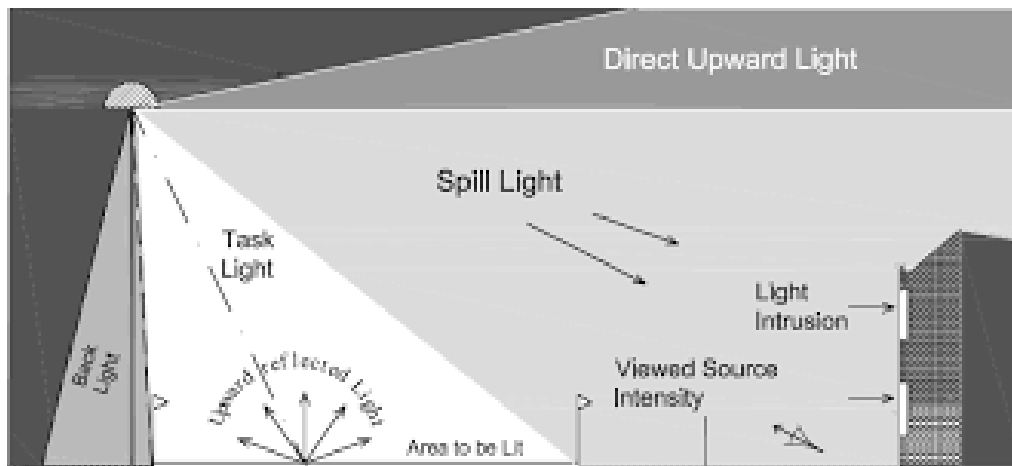
Today there is a move towards smaller bulbs with white light and better colour rendition, halogen still being in favour; though the lifetimes may be shorter. Very long-lived, cheap and energy-efficient **light-emitting diodes² (LEDs)** are now beginning to appear above our streets and main roads in very large numbers. It is not unrealistic to suggest that the vast majority of all lighting, both interior and exterior, will be in the form of LEDs in, say, twenty years'

time. Sadly, far too many LEDs are very bright – too bright for the lighting task – and their excess light reflects from the ground into the sky. Also, many LED lights have a blue-rich spectrum³ (see section 3 below) mimicking daylight, which is bad news for nocturnal wildlife and for humans trying to get to sleep. The least damaging types of LEDs would be amber or some other less-white colour. If white, 'warm white' (colour temperature about 2700-3000K) is preferable to blue-rich (4000K+)⁴.

Photo: Chris Wood



2) Terms used in describing good lighting, and waste light not directed to the area to be lit



*Diagram courtesy of the Institution of Lighting Professionals
(ILP Guidance Notes for the Reduction of Obtrusive Light)*

- **Task or Useful light** – light that fulfils the task for which the lamp was installed.
- **Obtrusive light** – light causing a problem of some kind through misdirection.
- **Spill light** - falls outside the area where it is needed.
- **Upward reflected light** - unwanted light bouncing off the ground.
- **Direct upward light** - wasted light shining above a light fitting (not necessarily vertically upwards – it may be escaping just one degree above the horizontal but will eventually end up in the sky).
- **Light intrusion** – over-bright and poorly directed light, often going in windows and/or causing glare and discomfort on other premises. Sometimes called **light trespass**, but this term is normally to be avoided as, in law, trespass is deliberate intrusion and the intrusive light is usually the result of ignorance rather than malice.

EXAMPLES

GOOD: Compact LED light directed downwards.



This and similar types are recommended for domestic, commercial, farmyard and similar uses: preferably with sensors to switch off when not needed.

Photo: Auraglow.

GOOD: A halogen floodlight, correctly angled, can light a large area.

Photo: Martin Morgan-Taylor



BAD: An LED floodlight that, even if tilted down, will shine above the horizontal

Photo: ILP



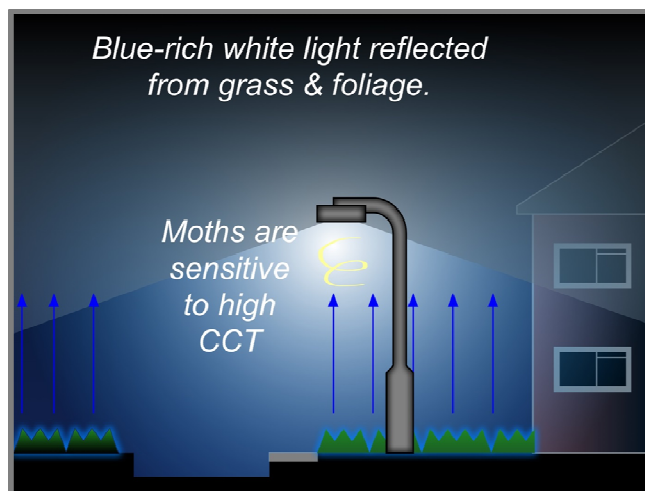
BAD: An LED floodlight on a hospital shining into ward windows: its wiring and short fitting bar mean that it cannot be tilted far enough downwards to illuminate the area to be lit. It will always emit upwards as well as down. *Photo: Bob Mizon*



3) A new threat to the environment: uncontained, blue-rich white lighting

White light comprises all spectral colours from violet-blue (380-495nm) to red (620-750nm). The proportion of blue in the white light mix is quantified by the Colour Correction Temperature (CCT) index; higher CCT equals more blue light relative to other colours.

Recent widespread introduction of blue-rich white lighting is causing concern among environmentalists and astronomers⁵. New and existing white light sources can have very high colour temperatures in excess of 4000 and even 5500K. This harsh blue-white light reflects from grass and foliage and scatters high into the atmosphere, causing much more sky-glow than current low CCT sodium-based lights. Good full cut-off shielding is counteracted by high CCT.



*To lessen sky-glow and interference with wildlife, all lights should have a colour temperature **less than 3000K** as a default specification. Exceptions must be justified.*

Graphic: Dan Nixon

4) Putting light where it is needed

This is not just for the protection of the night sky: well directed light, used only when needed (sensors have a large part to play here) has far fewer negative effects on neighbours, local wildlife and the tranquillity of rural areas to where spill light will travel. Light can easily be directed to the area to be lit by correct **angling, shielding**, and in some cases the use of **louvres** and **baffles**. The best method of course is to choose, with the lighting task in mind, an appropriately designed light fitting of **appropriate brightness** in the first place. Ask advice from your local council's lighting department if in doubt.

5) Part-night switch-offs – the CfDS view⁶

The CfDS does not call for the switching off of any necessary light, and if part-night switch-offs prove to be beneficial, the CfDS will support them.

The right light, in the right place, at the right time is what the CfDS would like to see. If switch-offs can be replaced with better lighting policies, using modern technology giving better light control and correct quantities of light, money and energy will be saved.

The impact on the surrounding countryside will be minimised.

Since its inception in 1989, the CfDS has been arguing against other negative effects of inefficient lighting: disruption of wildlife habitats, intrusion into premises (involving health issues), lights left on when not needed, for example in empty car parks, and light directed into the night sky to veil the stars.

In cases where all-night lighting is genuinely needed, for example in busy city centres, then the best, carefully controlled lighting technologies should be used.

Costs, crime and alternatives to switch-offs

The ever increasing cost of electricity has caused councils to reconsider keeping inefficient streetlights on all night, and many are now turning off streetlights overnight all over the UK. Large amounts of money have been

saved, and councils' CO2 footprints have been reduced.

Large scale switch-offs have often been met with dire predictions of crime waves, but there is no statistical evidence to indicate that overall crime has increased. In most areas where switch-offs have been introduced, crime has fallen. For example, Essex County Council carried out large scale switch-off trials in 2008 and crime actually fell by up to a third in the test areas. Such an outcome is not surprising, as streetlights are installed to help people see what they are doing in the darkness. Unfortunately that includes criminals. In fact most break-ins occur in broad daylight when premises are empty.

Alternative 1: Install efficient street-lighting Efficient lighting should always be installed to minimise energy use, prevent light pollution and nuisance to neighbours. Wildlife will also benefit from a natural night. Efficient lighting shines light only downwards towards the street, and not into people's homes, or into the sky. Modern full cut-off, energy efficient streetlights are the solution. LEDs are becoming commonplace due to their lower energy usage and longevity. However it is essential that blue-rich lighting is avoided due to the growing evidence of adverse effects on animals and humans. Over-bright blue-rich LEDs will create more skyglow by reflection than lights that they replace. For more information on this subject, see our Good Lighting page.

Alternative 2: Use dimmable streetlights New technology allows streetlights to be remotely controlled by dimming or switching off. Bright lights are unnecessary throughout the night when there are fewer people or vehicles. If necessary, lights can be brightened. Dimming is typically not noticed by the public. In York city centre, only 5% of respondents to a survey noticed that some lights had been dimmed. No crime was reported around dimmed lights. If adopted, both these methods would lead to a dramatic decrease in both the cost of street-lighting, and the amount of light pollution produced.

Alternative 3: Remotely controlled networks, some city-wide, will be the future of public lighting. Lights will respond to local circumstances, and central control will use them in the most efficient ways.

6) Common misconceptions met when discussing quality lighting and good practice

“Do you want me to turn outdoor lights off?”

Absolutely not.

We all need lighting, but directed **where it belongs** and not into the sky and into neighbours' premises.

“New streetlights do not contribute to light pollution.”

Unfortunately, new streetlights, including bright blue-rich LEDs, can sometimes cause more light pollution than the older lights they replace. Light pollution is not solely caused by old orange low-pressure sodium lights. Mathematical modelling shows that the main cause of light pollution is from light emitted at or just above the horizontal (mostly in the first ten degrees). There are many flat-glass/LED lights in the UK that do shine only downwards, but others are still tilted and shine though those critical ten degrees above the horizontal and cause skyglow.

“Full cut-off (downward-only) street-lights illuminate a smaller section of the road, so you need more of them.”

This is a very common misconception, even among local councils. It is not true that you need more street-lights if you use full cut-off units. The images below show the hood of the lighting unit at different positions over the bulb, and the angles of illumination.

The three lower lighting units are all full cut-off (flat-glass). A light like the one at lower right would illuminate a smaller section of road, but not so the lower-middle lamp. Indeed, in the lower-left case, the bottom of the bulb is just above the bottom of the hood, so no light can escape upward although the light can shine horizontally outwards to infinity. Such a light however, could also shine into neighbouring homes, disturbing people's sleep. So the CfDS recommends the ideal street-light to be the lower-middle type; no upward light, but retaining a good spread.

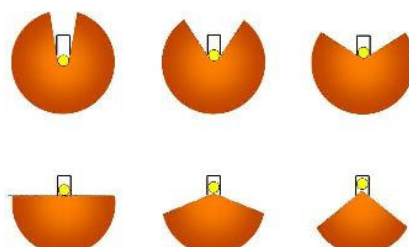


Image: CfDS

Other arguments against this misconception are:

Even if full cut-off lighting does illuminate a smaller section of road, taller columns can be used.

In many places, full cut-off lighting units are put on the old columns and achieve their effect.

On the M5 motorway in SW England, every five old-style lighting units have been replaced by FOUR full cut-off lights (i.e. further apart). The road is well lit.

Lighting professionals concur that the optics and the column height determine the spread of the light.

"More lights will decrease crime."

Those who sell and choose road lights make claims that they will deter criminals. There is no direct link between higher levels of lighting and lower crime levels.

Indeed, crime rates have decreased in many UK areas where street-lighting has been turned off in the small hours of the morning. In Essex, night-time crime almost halved in Saffron Walden and reduced by over a third in Dunmow after the lights were turned off - presumably because it made criminal activity more difficult. Search 'streetlight switch-offs crime increase' and 'streetlight switch-offs crime decrease' and see what you find. Are the thousands of unlit villages in the UK crime hotspots?

The National Institute of Justice in the USA conducted an assessment of crime and violence, and published their work in *Preventing Crime: What Works, What Doesn't, What's Promising* (www.ncjrs.gov/pdffiles/171676.PDF). The study found little evidence to support the misconception that bright lights equal safety, and suggested that poorly designed lighting might actually increase personal vulnerability. The report states:

"The problematic relationship between lighting and crime increases when one considers that offenders need lighting to detect potential targets and low-risk situations. Consider lighting at outside ATM machines, for example. An ATM user might feel safer when the ATM and its immediate surrounding area are

well lit. However, this same lighting makes the patron more visible to passing offenders. Whom the lighting serves is unclear."

Other studies on light and crime include those in B. Clark's *Outdoor Lighting Principles for Australia* (crime was cut drastically during a period of power cuts); the success of the IDA's "Dark Campus" program (Dark Campus Programs Reduce Vandalism and Save Money); the Ramsey and Newton studies for Home Office/CPU (found no link between lighting and crime); the West Sussex experience in the period in the '80s when many street lights were turned off late at night; the 2015 LSHTM/UCL Report on lighting: crime and accidents (no affect of switch-offs on either)

"Light pollution is inevitable in towns and cities."

Taxes should not be wasted on producing light that never hits the ground. The visibility of the night sky and comfortable ambient night-time lighting are not incompatible. Many urban councils have fitted new, 'sky-friendly' lights and at the same time improved their residents' night-time environment.

"Only astronomers need dark skies."

There are dark-sky campaigns in most developed countries in the world. Large numbers of their members are not astronomers, but concerned citizens who think that wasting energy and money, and spoiling the environment, are wrong. Everyone is entitled to see the stars: after all, they, together with the Big Bang that kick-started the Universe, created all the atoms that make up our bodies.

People who encounter the night sky for the first time on holiday in less urban places are without exception impressed, and although they are not astronomers would like to repeat the experience back home.

"Surely the problem of light pollution is just too big for us to make a difference."

Defeatist arguments will lead to nowhere but a worsening of a bad situation. Of course light pollution is not a problem that can be solved overnight - but activists can and are making a difference.

Politicians worldwide are beginning to consider the problem of light pollution. DEFRA, the UK government's environment department, has recently shown great interest in the issue and has published information for retailers and buyers of exterior lighting. A Royal Commission and a Parliamentary Select

Committee have examined the problem and made recommendations to the government.

Convincing just one Member of Parliament or local councillor may lead to change - just look at the example of Calgary, Canada, where the local administration has retro-fitted all street-lights city-wide and saved a lot of money.

The important thing is the momentum that the CfDS and fellow organisations have created - most people have now heard of light pollution, and are doing something about it.

Here is a problem with a simple solution that brings many benefits. In the words of Dr David Crawford, co-founder of the International Dark-Sky Association in the USA: **“With good lighting, everybody wins”**.

Recent history shows that big problems can be tackled with decisive action. Fifty years ago, London and many other big UK cities had a serious ‘smog’ problem caused by the burning of poor-quality fuels in homes, factories and power stations. People died. That all changed in the 1960s, when the Clean Air Act allowed only smokeless fuels to be used. Another example is the ozone hole. CFCs have been rapidly and successfully banned world-wide. The level of pollution from cars is being reduced dramatically following recent legislation.

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